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by Severnitin 2

Prediction Manufacturing Industry Potential Output and Growth: Case Study Indonesia's Manufacturing Industry 2000-2021

Abstract
The analysis of the output gap, which refers to the disparity between the actual and potential output, serves as a diagnostic tool to evaluate a country's economic position. The outcomes of this analysis provide insights into the current state of the country's business cycle. It is valuable as an initial framework for policy scenarios. Moreover, this study conducted an analysis on the estimation of potential output and output gaps in Indonesia's non-oil and gas processing industry sector. Three methodologies were employed: the HP (Hodrick-Prescott) Filter, the BP (Band-Pass) Filter, and the Production Function Approach. These approaches collectively indicate that the non-oil and gas processing industry in Indonesia fell slightly below its potential between 2020 and 2021. Consequently, policymakers should take this into account in both the short and long term. In the short term, inflationary pressures were brought about by a positive output gap, which required the government to prioritize implementing measures to control inflation. Meanwhile, medium-term structural reforms should continue to enhance potential output, including increasing labor force participation, sustainable investment for capital factors, and improving human capital quality and technological expertise for productivity factors.
Keywords: Indonesia, output gaps, HP filter, BP filter, manufacturing industry
JEL Classification: O4, E1, N15

Introduction

Indonesian economic analysts expressed various viewpoints concerning indications of deindustrialization in Indonesia. These views were substantiated by the declining proportion of manufacturing sector employees relative to the total workforce since 2002, as well as the decrease in the proportion of value added by the manufacturing sector in the country's GDP since 2005. These developments led the author to believe that Indonesia's economic growth was no longer solely reliant on natural resources, but also heavily dependent on the manufacturing industry. The main question raised was to what extent this shift had occurred. This inquiry emerged due to statistical data released by the Indonesian Central Statistics Agency (BPS), which revealed that the growth rate of the manufacturing industry sector in Indonesia was actually lower than the overall economic growth rate. Consequently, the term "deindustrialization" emerged and has been prevalent for the past decade.

In Indonesia, the term "industry" was commonly used to refer to the non-oil and gas processing industry or manufacturing, similar to many other developing nations. It typically denoted the transformation of raw materials into more valuable products. Nevertheless, "industry" also represented the skills and endeavors of organized individuals who aimed to create something more valuable and beneficial using natural resources and primary products. The process of industrialization, which was at the core of structural change catalyzed by the industrial revolution, consistently augmented production levels and employment, ultimately leading to unprecedented income growth. Therefore, promoting the development of the industrial sector was considered crucial for attaining sustainable development. The literature on growth and development emphasized a strong correlation between the manufacturing output and GDP growth (Pacheco-López, 2014). The debate surrounding the impact of industrialization on economic development has been extensive. In the course of history, all instances of successful economic development and catching up, starting from 1870, experienced growth and wealth accumulation through investments in their respective industries (Szirmai, 2012). Consequently, this resulted in a rise in the quantity and diversity of manufactured goods, generating employment opportunities and enhancing the standard of living.

During the process of economic growth, it has been noted that the industrial sector plays a crucial role as a driving force for growth due to its high potential for productivity improvement (Kaldor, 1967). Consequently, by implementing appropriate policies, the industrial sector has the capacity to propel the economy forward, transitioning from a sluggish recovery to a revitalization. It is widely acknowledged that developing nations would face considerable challenges in eradicating extreme poverty without achieving genuine industrialization capable of generating added value. The expansion of the industrial sector can be seen as an extension of the "Total Causality" process, where supply variables interact with demand. On one hand, the growth of industrial output leads to job creation, income generation, and increased demand. On the other hand, the expansion of industrial production fosters productivity growth, resulting in enhanced well-being for individuals. As part of this process, the continuous enhancement of the industrial production base has the potential to increase productivity through the establishment of new economic sectors, the adoption of advanced technologies, the manufacturing of sophisticated goods, and/or the integration into international supply chains that adhered to higher technological standards.

Industrial expansion was one of the most important measures of a nation's economic development. It was important for determining the direction of industrial policy formulation and national industrial development objectives. An analysis of industrial growth was essential. This was consistent with the government's attempts to generate high-quality industrial growth through its fiscal and monetary policy mix. The creation of industrial policies should take into account the business cycles that occurred in the economy, allowing the policies to effectively enhance the achievement of their objectives. The output gap technique was one of the basic diagnostic procedures used to determine where the economy was in the economic cycle.

Rodrik (2016) argues that the decrease in manufacturing in low- and middle-income economies was deemed premature for two main reasons. Firstly, these countries underwent deindustrialization at an early stage in history when their income levels were lower. Secondly, this premature reduction resulted in a missed opportunity for economic growth, as the manufacturing sector lost its dynamism. The decline in dynamism within the manufacturing sector raised concerns due to its significant role in technological innovations, generating trade surpluses, stimulating economic growth, enhancing economic productivity, and fostering regional development (Rodrik & Kennedy, 2007; Moretti, 2010; Manyika et al., 2012; UNIDO, 2013; Szirmai & Verspagen, 2015). Therefore, the manufacturing sector acted as an engine of economic growth (Kaldor, 1967; Thirlwall, 2002; Haraguchi et al., 2017) or as an escalator sector to stimulate the economy, especially the undeveloped, to achieve a high level of development (Rodrik, 2013; Rodrik, 2014). Rodrik (2016) suggests that industrialization played a crucial role in shaping contemporary society. During their respective industrialization phases, many developed countries experienced significant economic growth and attained high per capita incomes. However, as manufacturing declined in prominence within the economy, the growth engine lost much of its power, resulting in a lower growth rate.

The concept of an output gap encompasses two scenarios within an economy: either there is excess demand or there is underutilized production capacity (idle resources). The output gap was characterized as the difference between the actual output, which represented the value of economic output determined by demand during a business cycle, typically measured by Gross Domestic

Product (GDP), and the potential output. On the one hand, actual output reflected the economic output influenced by demand, while on the other hand, potential output indicated the optimal level of production at which labor and capital inputs were utilized sustainably in the long term, maintaining a stable the rate of natural unemployment and inflation. De Masi (1997) states that potential output signifies the maximum output an economy can produce without generating inflationary pressures. Both potential output and the output gap hold significance within the framework of macroeconomic policies. Potential output serves as a gauge of an economy's production capacity on the supply side, taking into account factors such as capital stock, labor utilization, and available technology. Over the long run, the efficient utilization of production factors at a given level of productivity played a significant role in determining potential output. However, in the short term, aggregate demand had the ability to drive production levels above the potential long-term output. This scenario exerted pressure in the form of excess demand in both the goods and labor markets, ultimately resulting in increasing of inflation.

The determination of the output gap has the ability to ascertain the stage of the economic conditions. Subsequently, the outcome can be taken into account when formulating fiscal and monetary policies. If the actual output surpasses the potential output (positive output gap), it signifies that the economy is experiencing a period of prosperity or expansion, resulting in inflationary pressures. As a result, a contractionary fiscal policy response, such as reducing expenditures, raising taxes, and implementing tight monetary policy like increasing interest rates, is necessary. Conversely, when the actual output falls short of the potential output (negative output gap), it indicates an inadequate utilization of production capacity. This leads to higher unemployment rates and deflation, indicating an economic recession. In such cases, an expansionary fiscal and monetary policy response is required to boost or create demand.

An accurate evaluation of industrial growth conditions and potential outputs can serve as the foundation for measuring and predicting medium- and long-term economies. Although the issue of output gaps is crucial in the formulation of fiscal and monetary policies, a comprehensive study of this in Indonesia is still very limited. This limitation can be understood considering that both potential outputs and gap outputs are unobserved or latent variables, and their measurements or estimates contain elements of error or uncertainty. If the element of uncertainty or measurement error is relatively large, then the use of potential outputs and gap outputs to craft policy recommendations may result in errors. Therefore, the estimation of potential outputs and gap outputs must be carried out using scientific methods and evaluated with a methodology that aligns with the underlying economic theory.

One study conducted for the estimation of potential output and output gaps in Indonesia was carried out (Van Der Eng, 2009; Tjahjono et al., 2010; Rinaldi & Saputro, 2017). This study prioritizes an approach using the production function model, where potential output is calculated based on the production function, which established a relationship between the output gap and the inflation rate. Furthermore, Mitra et al. (2015)) conducted a study for the estimation of potential output and output gap in Sweden using several approaches that are generally divided into two categories: univariate and multivariate methods. A similar study was also conducted by Araujo et al. (2004), who attempted to estimate potential output and output gap using a series of univariate methods such as the Hodrick-Prescott (HP) filter, Band-Pass (BP) filter, moving average, and others, as well as the production function approach and structural VAR.

Based on the aforementioned explanation, the objective of this study was to assess the potential output and output gap of Indonesia's non-oil and gas industry growth, along with its position in the business cycle. This will be achieved through the utilization of various analytical approaches, with the aim of offering policy recommendations to foster sustainable economic growth. Previous research has primarily concentrated on estimating economic growth by utilizing a potential output estimation method that was relatively similar, based on annual data up until 2013 (Nasution & Hendranata, 2014). However, "this paper focuses specifically on the non-oil and gas industry, employing more recent and updated data, and utilizing a quarterly time frame (high frequency) to enhance the analysis and provide a more comprehensive understanding of the dynamics involved. Given the wide range of available methods, this study will employ several approaches, both univariate and multivariate, and select the best model based on its ability to explain the dynamics of inflation in Indonesia over time."

Research Method

The research utilized the documentation method as the data collection approach, involving the gathering of relevant data from selected reports. This study made use of secondary data acquired from institutions dedicated to publishing data for the benefit of data users. The study relied on time series data in quarterly intervals, covering the period from the first quarter of 2000 (2000q1) to the fourth quarter of 2021 (2021q4). The data sources included CEIC (an economic database provider), the Central Agency of Statistics (BPS), Ministry of Industry of Republic of Indonesia, Ministry of Finance of Republic of Indonesia, and Total Economic Database. Unfortunately, without specific details on the data used in the paper, such as the specific variables or indicators, it is not possible to provide further information about the data sources or the specific data points analyzed in the study.

Table 1. Variable, Dimension, and Sources

Variable	Definition	Unit	Source
Real Gross Domestic Product: Seasonal Adjusted (YSA)	GDP data, whose effects/patterns have been eliminated through specific statistical methods	Billion Rupiah	BPS and CEIC, processed
Real Gross Domestic Product manufacturing sector: Seasonal Adjusted (YMSA)	The economic information regarding the Gross Domestic Product (GDP) specifically related to the manufacturing sector that is classified into two-digit codes. Certain statistical methods have been employed to eliminate the effects and patterns from the GDP.	Billion Rupiah	BPS and the Ministry of Industry, processed

Real Gross Fixed Capital Formation (I)	During a specific time frame, there has been a rise in the quantity of capital goods (investment), encompassing building (infrastructure), machinery, equipment, vehicles, other tools.	Billion Rupiah	BPS
Depreciation Rate (δ)	The weighted average percentage of depreciation rate for each component forming the PMTB.	Percent	BPS
Number of Workers (L)	The population within the age range suitable for employment or working	Million People	BPS
Number of Each Sectoral Manufacturing Workers (LM)	The population of individuals within the appropriate working age range who are employed in the manufacturing sector.	Million People	BPS and the Ministry of Industry, processed
Labor income share (1-α)	Elasticity of output to labor	Percent	Total Economic Database
Inflasi (π)	Measured using consumer price index (CPI)	Percent	BPS

Estimating potential output and output gaps typically involves two primary approaches: the univariate method and the quasi-theoretical method. The univariate method is a statistical approach that focuses solely on statistical properties without considering macroeconomic variables' relationships. This process involved the division of time series variables into permanent and cyclical components. Notable examples of univariate methods include the Beveridge-Nelson, Baxter King, HP filter, and BP filter. In contrast, the quasi-theoretical approach constructs models based on economic theory and the interconnections between macroeconomic variables. The production function approach belongs to this category. Technically, the univariate approach is simpler compared to the multivariate approach. However, this does not mean that the results produced with the univariate approach are always inferior to the multivariate approach. For example, a study conducted by Araujo et al. (2004) for estimating the output gap in Brazil using various univariate and multivariate methods found that the Beveridge-Nelson decomposition method (an univariate method) performed the best. The study also found that including output gaps as one of the free variables in the Phillips curve equation significantly improved the predictive power of the model. In contrast, a study by Cerra & Saxena (2000) for estimating the output gap in Sweden, which also used several univariate and multivariate approaches, found that the production function approach (a multivariate method) was the best compared to other methods. However, due to the difficulty of estimating labor market conditions with full employment in Sweden, the univariate approach remained useful in decomposing labor variables. Another study conducted by Tjahjono et al. (2010) for estimating potential output and output gaps in Indonesia using various univariate and multivariate methods found that the multivariate approach performed better than other approaches. This study employed a multivariate model with an unemployment and capacity utilization approach. The model incorporated relevant empirical relationships between actual GDP, potential GDP, unemployment rate, inflation rate, and manufacturing sector capacity utilization within the framework of a small macroeconometric model.

To estimate potential output, this study employs three methods: time series filtering techniques such as the HP Filter and BP Filter, as well as the quasi-theoretical approach using production functions. The utilization of these analytical methods is described as follows: Statistical techniques relied on time series filtering methods to estimate actual output data trends by separating or filtering the data into cyclical and trend components. Well-known methods used in this approach include the HP filter and the BP filter. The main advantage of this method lies in its relative simplicity and transparency. However, since it relies solely on statistical calculations, it may lack a strong connection to economic theory and ignore the relationships between economic variables, making it difficult to explain the dynamics according to economic theory. The HP filter is a commonly used smoothing technique to estimate potential output. It minimizes the difference between actual output and potential output by constraining the rate of change in potential output for the entire observation sample (T). The HP Filter equation can be written as follows:

$$Min \sum_{t=1}^{T}(y_t - y_t^*)^2 + \lambda \sum_{t=2}^{T=1}[(y_{t+1}^* - y_t^*) - (y_t^* - y_{t-1}^*)]^2 \quad (1)$$

where y is the actual output (real GDP), y* is the potential output, and λ is the weighting factor that determines the degree of smoothness of the trend. A smaller value of λ indicates that the potential output tends to closely follow the actual output, while a larger value of λ results in a smoother potential output that deviates further from the actual data. To determine the value of λ, a common practice is to use the equation λ = 100 q2, where q represents the periodicity of the data. For example, λ would be set to 100 for annual data, 1600 for quarterly data, and 14400 for monthly data.

The BP filter is a linear filter that calculates weighted moving averages on both sides of the data, allowing only the components within a specified frequency range (band) to pass through. It separates the time series data into different frequency components, with the focus on capturing the medium-frequency cyclical component, often associated with business cycles. The determination of the duration range for the filter depends on the knowledge of the length of the business cycle in a particular country, which may vary or may not be readily available. As a general guideline, the standard practice assumes a lower cycle range of 6 quarters (1.5 years) and an upper cycle range of 32 quarters (8 years). The BP Filter employs decomposition theory to isolate the data into various frequency components.

$$X_t = y_t + \widetilde{X_t} \quad (2)$$

In the production function approach and growth accounting, the potential output is connected to input factors. Solow's theory of growth asserts that the level of output (economic growth) is influenced by the inputs of both capital and labor, which mutually interact under a given level of technology. Technology represents the knowledge and efficiency in producing goods and services. The level of technological progress can be indicated by the Total Factor Productivity (TFP), which reflects the efficiency of each component of the production factors. Higher TFP implies more efficient use of the production factors in generating output. Solow's growth model can be expressed as follows:

$$Yt = At.Kt^{\alpha}.Lt^{1-\alpha} \quad (3)$$

In this context, Y symbolizes the production of goods and services, A represents Total Factor Productivity (TFP), K signifies capital, L denotes labor, and α denotes the contribution of capital to output. An increase in production efficiency leads to a shift in the production function curve (from point A to B). Technological advancements result in increased output by shifting the production function curve from point B to C. Additionally, an increase in inputs from X1 to X2 leads to an increase in output from point C to D as shown in the Fig. 1.

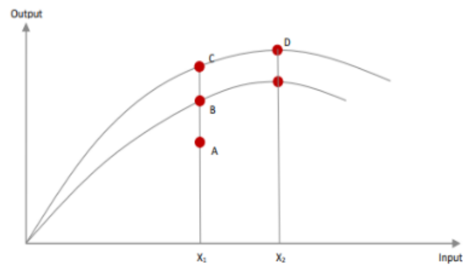


Figure 1. Production function

TFP is not directly observable and is typically derived as a residual in the Solow growth accounting framework, as shown in the following equation:

$$Y' = A' + \alpha K' + \beta L' \quad (4)$$

The symbol (') indicates the each component growth, Y' denotes the output growth, K' represents the capital growth, L' represents the workforce growth, A' signifies the technological advances growth, α denotes the elasticity of capital to output, and β signifies the elasticity of labor to output. When estimating potential output using this production function approach, the following stages need to be completed.

The first step involves estimating the initial capital stock using the accelerator model approach. The initial capital stock (χt) can be estimated using the accelerator model approach, which takes into account the additional new investment (I_t), the GDP growth rate (g_t), and the depreciation value (δ_t). The formula is as follows:

$$\chi t = I_t(g_t + \delta_t)/Y_t \quad (5)$$

Capital stock estimation using the perpetual inventory method, the capital stock (K_t) can be calculated using the perpetual inventory method, which involves updating the previous period's capital stock (K_{t-1}) by accounting for depreciation (δ) and adding the additional new investments (It). The formula is:

$$K_t = (1 - \delta)K_{t-1} + I_t \quad (6)$$

To obtain the trend component of the labor and TFP variables, a smoothing process was performed. In this paper, the HP filter was used for this purpose.

Calculating TFP, TFP represents the portion of output (Yt) that cannot be explained by the inputs of capital (Kt) and labor (Lt) according to the production function. It can be calculated using the formula:

$$A_t = Y_t/K_t^{\alpha} * L_t^{(1-\alpha)} \quad (7)$$

Calculating potential output using aggregate production functions. After obtaining the components of potential capital (K_t^*), potential labor (L_t^*), and potential TFP (A_t^*), the potential output (Y_t^*) can be calculated using the aggregate production function.

$$Y_t^* = A_t^*.K_t^{*\propto}.L_t^{*1-\propto} \quad (8)$$

The production function approach has the advantage of being built on economic theory and incorporating key macroeconomic variables. This approach can provide insights into the dynamics of potential output estimates and output gaps, drawing from both theoretical and empirical explanations. Additionally, it can help identify the factors driving past growth and highlight structural changes in the growth trend. However, it should be noted that this approach still relies on time series filtering techniques, which have their limitations.

To calculate the output gap, the estimated potential output (Y_t^*) is compared to the actual output (Y_t) using the following formula:

$$GAPt^* = ((Yt - Yt^*)/Yt^*)/* 100 \quad (9)$$

Where $GAPt^*$ represents the output gap in period t, Yt is the actual GDP/output level, and Yt^* is the potential GDP/output level.

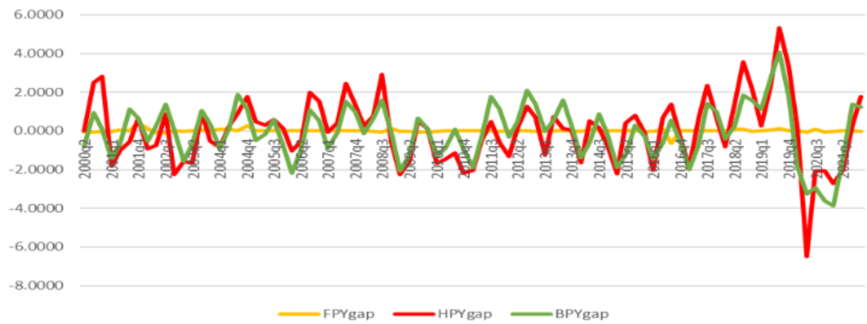
To evaluate the potential output estimation method, the approach of the Phillips curve model is utilized, which examines the relationship between the output gap and the inflation rate's dynamics. The selection of the optimal model is determined by the extent to which the output gap can explain inflation dynamics, taking into account the inflation rate's fluctuations over different time periods (Nasution & Hendranata, 2014). The expression of the Phillips curve model is as follows.

$$\pi_t = \alpha + \sum_{j-1}^{4} \beta_t \pi_{t-j} + \sum_{j-0}^{4} \beta\lambda_j ygap_{t-j} + \varepsilon_t \quad (10)$$

Where π is the inflation rate and ygap denotes the output gap.

Result and Discussion

In general, consistent patterns and directions of movement were observed in the estimates of potential and gap output using the HP filter, BP filter, and production function methods, despite varying magnitudes. These estimates of potential growth rates from 2000 to 2021, obtained through three approaches, demonstrate a remarkable level of consistency. The provided dataset further indicates the manufacturing sector of Indonesia has experienced relatively stable growth since the crisis period in the early 2000s until the present, as evidenced by the growth rates. Additionally, the data reveals a minimal difference between the actual and potential growth rate. The illustrations also depict the impacts of the crises that took place in 2008 and during the COVID-19 pandemic in 2020. Figures 2 demonstrate that the actual output trend was slightly below the potential output estimated through the production function (FPYgap) and HP filter (HPYgap) approach, and marginally lower than the potential output estimated using the BP (BPYgap) filter approach.



Source: BPS processed

Figure 2. Output Gap 2000q2-2021q4

Figures 2 illustrated the dynamics of Indonesia's industry tides throughout the 2000-2021 period. Consumption growth played a crucial role in driving the post-crisis economic recovery process during this period. Ikhsan (2005), suggests that the increase in consumption was driven by several factors, including deferred consumption from the crisis period, regional minimum wage hikes, subsidies from government, and an expansion of consumer credit. From 2003 to 2008, the industry's growth tended to surpass its potential level, resulting in a positive output gap. However, at the end of 2008, the global financial crisis unfolded, triggered by the emergence of subprime mortgages, leading to the closure of several major companies in the US. This situation also impacted Indonesia's industry, causing a slowdown in growth and a return to negative output gap levels in 2008q2 and 2010q1.

Moreover, in Indonesia it is apparent that the industry witnessed a positive output gap between 2011 and 2014, which subsequently turned negative from 2015 onwards. The surge in global demand for commodities, known as the commodity boom, primarily drove the positive output gap during the period of 2011-2015. As a country that produces and exports raw commodities such as coal, Crude Palm Oil (CPO), and metal minerals, Indonesia experienced a significant boost in its economic performance. Generally, the high global demand and subsequent price increases during this period resulted in higher incomes for the population, leading to increased demand for goods and services. Additionally, this situation was accompanied by inflationary pressures due to limited economic potential.

Between 2016 and 2017, there was a global economic downturn characterized by a slowdown in economic growth in developed and developing countries. This was accompanied by a significant drop in global commodity prices, which had an impact on Indonesia's industry and resulted in slower growth. As a result, the actual output of the Indonesian industry fell below its potential level, indicating a negative output gap. Between 2017 and 2019, the output gap began to approach positive levels once again. However, the COVID-19 pandemic in 2020 created additional challenges for the industrial sector, affecting both the supply and demand sides. On the supply side, there were disruptions in global supply chains, while on the demand side, reduced purchasing power hindered the industry. Numerous prospective manufacturing industries were compelled to curtail operations and reduce production, resulting in a significant downturn within industrial sector in Indonesia.

The estimated Indonesia's growth of non-oil and gas processing industry in 2021 was projected to be 3.8%, higher than the actual growth. This suggests that there is limited potential to increase the industry's output and reach its current potential level. This situation provides valuable information for improving the national economy in the short and medium terms. In the short term, according to the Phillip curve model, a positive output gap worsens inflationary pressure. Therefore, controlling inflation requires implementing countercyclical fiscal and monetary policies, such as regulating the money supply and setting the benchmark interest rate, to alleviate the pressure of rising inflation expectations. On the other hand, in the medium term, it is crucial to enhance potential output by increasing labor, investment, and productivity in production capacity. Analyzing efforts to improve production capacity involves decomposing the estimated potential output and output gaps using the production function approach, as explained in the following section.

Table 2. The regression results based on Phillips Curve model

Variable	HP filter	BP filter	Production Function
C	**1.2191****	**1.2478****	**1.2926****
Ygap	0.0043	-0.2803	1.0546
Ygap(-1)	0.0514	0.6103	1.3379
Ygap(-2)	-0.0486	-0.6006	-0.4847
Ygap(-3)	0.1330	0.6621	-0.7699
Ygap(-4)	0.0049	-0.3402	**4.5707***
Inflation(-1)	**0.9950****	**0.9904****	**1.0014****
Inflation(-2)	-0.0437	-0.0364	-0.0460
Inflation(-3)	-0.0123	-0.0061	-0.0302
Inflation(-4)	-0.1415	-0.1532	-0.1471
R^2	**0.7940**	**0.7943**	**0.8068**
Adj R^2	**0.7686**	**0.7689**	**0.7829**
F-statistic	**31.2576**	**31.3136**	**33.8645**
Prob(F-stat)	**0.0000**	**0.0000**	**0.0000**
DW stat	**1.8675**	**1.8691**	**1.8483**

*) significant at α = 1%; **) significant at α = 5%.

The regression outcomes of the Phillips Curve model revealed that all three approaches produced comparable R-squared values and significant results in both t-tests and f-tests when explaining the variations in the inflation rate. This indicates that the three methods were successful in estimating potential output. However, the production function method offered an advantage by providing an explanation of the primary factors that drive growth. Additionally, the production function approach was utilized to analyze the impact of labor, capital, and productivity factors on economic performance, encompassing both historical patterns and future trends.

To conduct the decomposition analysis, the Solow growth model was utilized within the production function approach. This allowed for establishing a link between growth and the factors that drive it, such as labor, capital, and TFP (Total Factor Productivity). Consequently, it became possible to estimate the factors contributing to economic growth from 2000 to 2021, both in terms of actual output and potential output, as demonstrated in Table 3 and 4.

Table 3. Production Factor Components Contibution to The Actual Output

Decomposition	2000-2004	2005-2009	2010-2014	2015-2019	2000-2021
Average Growth (%)	5.15	3.94	4.8	4.54	4.16
Labor (%)	-0.01	-0.01	-0.004	-0.02	-0.002
Capital (%)	4.27	3.52	4.5	4.35	3.82
TFP (%)	0.88	0.44	0.3	0.2	0.34

Based on the information presented in Table 3, the performance of Indonesia's non-oil and gas processing industry was primarily influenced by the role of capital, accounting for 90.4% (3.82 out of 4.16%) of the industry's growth. Total Factor Productivity (TFP) contributed 9.7% (0.34 out of 4.16%), while labor had a minimal contribution of -0.1% (-0.002 out of 4.16%). The significant impact of capital aligns with the observed upward trend in the investment-to-GDP ratio, which has consistently increased since the crisis period. Conversely, the contribution of labor has gradually declined over time.

Table 4. Production Factor Components Contribution to The Total Potential Output

Decomposition	2000-2004	2005-2009	2010-2014	2015-2019	2000-2021
Average Growth (%)	5.67	3.98	4.79	4.54	4.2
Labor (%)	-0.01	0.03	-0.004	-0.02	0.01
Capital (%)	4.73	3.55	4.49	4.35	3.86
TFP (%)	0.95	0.44	0.3	0.2	0.34

Furthermore, the potential output decomposition results provided in Table 4 demonstrated a tendency to display comparable conditions to the actual output decomposition results observed between 2000 and 2021. A closer scrutiny of the analysis period from 2015 to 2021 revealed a scenario in which the actual output declined below the potential output. This occurrence predominantly stemmed from the lower contributions of TFP and capital in comparison to their potential levels, while the contribution from the workforce slightly exceeded its potential.

As mentioned earlier, the findings from the analysis of economic growth and potential output suggest that the scope for enhancing and optimizing economic potential is becoming increasingly limited. Consequently, there is a pressing need to undertake efforts that boost economic capacity, leading to an increase in potential output. These efforts primarily revolve around enhancing the supply side, which encompasses labor, capital, and productivity, all of which are integral components of the production function approach.

According to the information presented in Tables 3 and 4, the primary driver of economic growth in Indonesia is primarily attributed to an increase in accumulation of capital. In contrast, the contributions of both the labor and TFP component have shown a declining trend in recent years. This pattern reflects a situation where there is a growing mastery of technology but relatively low productivity. Anand et al. (2014) suggest that the low TFP contribution can be attributed to various factors, including a low level of R & D, unsufficient infrastructure, the economy, particularly the processing industry sector, suffered from a dearth of complexity. Additionally, the licensing procedures during the business startup process posed challenges due to their complex nature. These findings serve as an early indication that structural reforms should be a key focus for optimizing the sources of national economic growth. Government policies aimed at supporting these structural reforms may involve implementing a combination of measures that target improvements in labor, investment, and productivity factors.

The industry drove the post-crisis economic recovery from 2011 to 2014, but experienced a negative trend from 2015 onwards. The period from 2011 to 2015 witnessed a positive output gap, primarily fueled by a surge in global commodity demand, specifically in the production and exports of coal, CPO, and metal minerals. The high global demand and price increases during this period led to increased incomes and subsequently boosted the demand for goods and services. However, this led to inflation due to limited economic potential. In 2016-2017, global commodity prices fell and economic growth in both advanced and developing countries slowed, which affected Indonesia's slow-growing industry. Consequently, the output of the Indonesian industry declined (negative output gap). From 2017 to 2019, various approaches indicated a positive output gap. However, the COVID-19 pandemic in 2019-2020 severely impacted the industrial sector from both the supply and demand sides. Global supply chain disruptions disrupted the supply, while decreased purchasing power disrupted the demand. As a result, Indonesia's industrial sector contracted as future manufacturing industries reduced utilities and production. According to the Phillip curve model, short-term inflationary pressures can arise from a positive output gap. Therefore, countercyclical fiscal policies and monetary policies controlling the money supply and benchmark interest rates can help manage inflation expectations and control inflation. In the medium term, increasing production capacity through labor, investment, and productivity is crucial. Analyzing production capacity increases by decomposing potential output and output gaps using the production function approach is recommended. The projected growth rate for Indonesia's non-oil and gas processing industry in 2021 is estimated to be 3.8%, which is slightly above the actual growth rate. This limited growth potential of the non-oil and gas processing industry hampers its output expansion. However, this situation can contribute to short and medium term improvements in the economic fundamentals. The Indonesian government's goal of achieving 6.5%-7% growth in the non-oil and gas processing industry within the next three years (by 2024) seems unlikely due to its significantly lower potential output growth.

In the short term, a combination of fiscal and monetary policies was implemented to control inflation and alleviate the pressures of rising prices. In the medium and long term, policy measures were undertaken to promote structural reforms that enhance production factors such as labor, capital, and productivity. Regarding the labor aspect, the growth rate of the workforce continued to decelerate, but there was still potential for improvement. This improvement could be achieved through various means, including: Prioritizing the training of a critical mass of workers in new technologies, as the private sector's involvement was challenging to rely on; Upgrading existing training centers to offer a wider range of programs in new technologies; Ensuring access to institutions that provide advanced technical training for learners; Providing funding for new technology training programs specifically designed for small and medium-sized enterprises; Encouraging the participation of foreign firms, as seen in the automotive industry, to expand their training centers; Exploring the potential of employing skilled women in various sectors; Increasing funding for apprenticeships to offer on-the-job training opportunities for university students, capitalizing on the increasing number of Indonesian graduates in science, technology, engineering, and math (STEM); and Creating training programs that concentrate on technological entrepreneurship. By implementing these measures, it is expected that the workforce's potential can be further developed and contribute to technological advancements and overall economic growth.

Regarding capital, the endeavors to enhance its potential were directly evident in the acceleration of investment growth. Generally, there are three approaches to foster investment, namely: Introducing new measures to simplify licensing procedures, reducing inefficiencies economics, and amending policies, rules, and regulations that are unfavorable to the market. These efforts aim to facilitate investors in making investments; Developing essential infrastructure and supportive facilities for industry players. The government should prioritize planning efforts and provide the necessary infrastructure as it cannot solely rely on the private sector to fulfill this role; and Promoting an increase in foreign investment, particularly in export-oriented sectors. This will help alleviate the burden on the current account balance caused by investments and can be offset by the addition of export capacity. By implementing these measures, the potential of capital can be further harnessed, leading to increased investment and economic growth.

To unlock growth through technological transformation, several policy actions were undertaken, including: Resolving gaps in both "hard" and "soft" infrastructure and establishing advanced innovation institutions; Enhancing digital infrastructure at the national level to reduce regional disparities; Creating long-term investment plans for research and development (R&D) and adopting international funding practices for research; Evaluating the necessity of new extension services and intermediate institutions, such as research and technology organizations, to offer technological assistance to businesses; Enhancing institutional capacity to effectively implement policies across various regions; and Regularly update regulatory frameworks to accommodate the changes introduced by new technologies. By implementing these policy measures, the aim is to foster technological advancements and facilitate economic growth in a sustainable manner.

Conclusion

The output of Indonesia's manufacturing industry was best estimated using the Production Function Method and the BP filter. Fluctuations in Indonesia's manufacturing industry occurred from 2010 to 2021. The author argues that the deindustrialization process observed in Indonesia since 2002 has had a negative trajectory. The deindustrialization in Indonesia was not an inherent result of a well-established development process, but instead, it was triggered by shocks to the Indonesian economy, exerting a significant impact. Finally, for further direction, the author suggests that a policy simulation scenario should be carried out to facilitate the unlocking of industrial growth through the adoption of new emerging technologies.

Appendix (Optional)

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